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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/047,455	01/15/2002	Edwin L. Piner	N00400/70013 RJP/RHW	1054

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EXAMINER

HU, SHOUXIANG

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 12/01/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/047,455

Applicant(s)

PINER ET AL.

Examiner

Shouxiang Hu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 July 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-38 is/are pending in the application.
- 4a) Of the above claim(s) 33-38 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-32 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 5, 6. 6) ☐ Other: _____

DETAILED ACTION

Election/Restrictions

1. Claims 33-38 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in Paper No. 7.
2. Applicant's election with traverse of Group I in Paper No. 7 is acknowledged. The traversal is on the ground(s) that search and examination of all claims would place no undue burden on the examiner. This is not found persuasive because, as explained in the previous office action,

The inventions of Group I and Group IIB are distinct; they have acquired a separate status in the art as shown by their different classification; and the search required for Group I is not required for Group II. Although only a few of classes/subclasses were given in the previous office action, they are only the exemplary ones. Along with required key word search, a thorough search is required in each of the classes/subclasses: 257/13, 19, 79, 103 and 190-192, for Group-I invention; and 438/22, 93, 94, 483, 758, 761, 767, and 936, for Group-II invention. Thus, search and examination of all of the claims would impose a substantially undue burden upon the examiner.

The requirement is still deemed proper and is therefore made FINAL.

Claim Objections

3. Claim 14 is objected to because of the following informalities and/or defects:

The term of "the substrate" recited in claim 14 should read as: --a substrate--.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1-3, 5-7, 10, 11, 19-21, 23 and 25 are rejected under 35 U.S.C. 102(b) as being anticipated by Ito (WO98/44569; also see US 6,583,442 for its English translation).

Ito discloses a semiconductor structure (see US 6,583,442; Fig. 1, col. 3, lines 45-52, and col. 4, lines 1-10), comprising: a silicon germanium component or layer (at least the top portion of the substrate layer similar to layer 101 in Fig. 1); and a gallium nitride material component or layer (similar to layer 102, 103, and/or 104).

Regarding claims 3 and 5, at least the bottom portion of the SiGe substrate layer (101) can be regarded as a silicon germanium substrate.

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Regarding claim 11, at least the layer 102 can be regarded as intermediate layer formed between the silicon germanium component and the gallium nitride material component (103 and/or 104).

Regarding claims 19-21, the gallium nitride material component in Ito can be $\text{Al}_x\text{In}_y\text{Ga}_{(1-x-y)}\text{N}$ alloy, with the sum of $(x+y)$ being less than 0.2 or being zero (see col. 4, lines 1-3).

Regarding claim 23, the gallium nitride material layer in Ito forms at least a portion of a device region.

Regarding claim 25, the structure of Ito forms an LED.

6. Claim 1-3, 7, 9 and 21 are rejected or further rejected under 35 U.S.C. 102(e) as being anticipated by Yokogawa et al. ("Yokogawa"; US 2002/0060315 A1).

Yokogawa discloses a semiconductor structure (see the substrate 10 and the overlying multiple layers in Fig. 4, and also see Section 0160), comprising: a silicon germanium component or layer (a SiGe active layer); and a gallium nitride component or layer (a GAN substrate).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 15, 24 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ito.

The disclosure of Ito is discussed as applied to claims 1-3, 5-7, 10, 11, 19-21, 23 and 25 above.

Regarding claim 15, although Ito does not expressly disclose that the SiGe substrate can have a monocrystalline structure, office notice is taken that that single crystal SiGe substrate is an art-recognized common substrate for achieving good performance in devices formed thereon, compared with that of non-single crystal one.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Ito with the SiGe layer having a monocrystalline structure, so that a device formed thereon with good performance would be obtained.

Regarding claims 24 and 26, it is note that it is art-known that gallium nitride material can be desirably used to form a high quality FET and/or a high quality laser.

9. Claims 4, 8, 13, 14 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Bulsara et al. ("Bulsara"; US 6,589,335).

The disclosure of Ito is discussed as applied to claims 1-3, 5-7, 10, 11, 19-21, 23 and 25 above.

Although Ito does not expressly disclose that the SiGe can be graded and formed on a silicon substrate, one of ordinary skill in the art would readily recognize that a silicon substrate can be desirably used for lower the cost, and that a graded SiGe layer

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can help to improve the lattice match between the silicon substrate and a III-V expitaxial layer, as evidenced in Bulsara (see the Ge-increasing graded GeSi layer 104 on the silicon substrate 102 in Fig. 1A).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the Si-based graded SiGe layer of Bulsara into the semiconductor structure of, so that a structure having improved quality in the Gallium nitride layer would be obtained with low cost.

10. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Redwing et al. ("Redwing"; US 5,874,747).

The disclosure of Ito is discussed as applied to claims 1-3, 5-7, 10, 11, 19-21, 23 and 25 above.

Although Ito does not expressly disclose that the structure can further include a graded intermediate layer, one of ordinary skill in the art would readily recognize that the an graded intermediate layer can be desirably formed on a substrate recognize that a graded intermediate layer can be desirably formed on a substrate before the expitaxial growth of the overlying gallium nitride layer for improving the lattice match and thermal match therebetween, as evidenced in Redwing (see col. 18, line 39 through col. 19, line 4).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Ito with a graded intermediate layer being included, as taught in Redwing, so that a structure with high

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quality Gallium nitride layer would be obtained through improved good lattice match and thermal match.

11. Claims 16-18, 22 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Haga et al. ("Haga"; US 5,403,673).

The disclosure of Ito is discussed as applied to claims 1-3, 5-7, 10, 11, 19-21, 23 and 25 above.

Although Ito does not expressly disclose that the SiGe and gallium nitride components (or layers) can have a thermal match of within $\pm 25\%$, that the SiGe material can be $\text{Si}_x\text{Ge}_{1-x}$ with x being greater than 0.8, and/or that Gallium nitride material have a crack level of less than $0.005\text{um}/\text{um}^2$, one of ordinary skill in the art would readily recognize that thermal match, crack level in the epitaxial layer and the composition in the underlying layer are all art-recognized parameters of importance subject to routine experimentation and optimization, as that thermal match and low crack level are always desirable for achieving high level device performance (as readily evidenced in the prior art references such as Redwing) and that the quality of the epitaxial gallium nitride layer always depends on the lattice match and thermal match with the underlying $\text{Si}_x\text{Ge}_{1-x}$ layer, which in turn depends on the composition of the underlying $\text{Si}_x\text{Ge}_{1-x}$ layer, as evidenced in Haga (see col. 4, lines 43-49, col. 13, line 55 through col. 14, line 13, and col. 14, line 42 —45).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the semiconductor structure of Ito with the thermal

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match being within +/- 25%, with the composition ratio x in $\text{Si}_x\text{Ge}_{1-x}$ being greater than 0.8, and/or with Gallium nitride material having a crack level of less than $0.005\text{um}/\text{um}^2$, through routine experimentation and optimization, as being taught in Haga, so that high quality Gallium nitride layer and high level device performance would be obtained through good lattice match between the epitaxial Gallium nitride layer and the underlying SiGe layer.

12. Claims 27, 28, 31 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ito in view of Gao et al. ("Gao"; US 6,563,143) and/or Ramdani et al. ("ramdani"; US 2002/0060317 A1).

The disclosure of Ito is discussed as applied to claims 1-3, 5-7, 10, 11, 19-21, 23 and 25 above.

Although Ito does not expressly disclose that the structure can be a hybrid one having a SiGe device and a gallium nitride device, one of ordinary skill in the art would readily recognize that hybrid structure of different semiconductor devices can be desirably formed on a same substrate in order to maximize the structure performance through the best use of the individual devices, as readily evidenced in Gao (see the Ge device 116 and the GaAs device in Fig. 1E) and Ramdani (see the compound device 160 and the silicon device 146 in Fig. 14).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the hybrid structure of Gao and/or Rambani

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into the semiconductor structure of Ito, so that hybrid structure with maximized structure performance would be obtained.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is (703) 306-5729. The examiner can normally be reached on Monday through Thursday, 7:30 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (703) 308-1690. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9318.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

SH
November 18, 2003

SHOUXIANG HU
PRIMARY EXAMINER

